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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	T. KAJI et al.
Serial No.:	10/052,538
Filed:	January 23, 2002
Title:	PLASMA PROCESSING APPARATUS PROCESSING METHOD
Group:	1792 Examiner: A. CROWELL **CONF. NO. 4015**

------ NOTICE OF APPEAL FILED NOVEMBER 19, 2007 ----

SUBMISSION OF APPELLANT'S BRIEF

Mail Stop: Patent Appeals (Fee) **May 19, 2008**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Sir:

In response to the Final Office Action mailed July 17, 2007, the present Appellant's Brief is being submitted under 37 CFR §41.37, in connection with the appeal of the above-identified application. A Notice of Appeal was timely filed on November 17, 2007, together with a Petition for Extension of Time, and a further Petition for Extension of Time is being filed herewith along with the requisite fee for filing an Appellant's Brief.

I. REAL PARTY IN INTEREST

The real party in interest is Hitachi, Ltd. of Japan.

II. RELATED APPEALS AND INTERFERENCES

It is noted that related application Serial No. 10/808,559, filed on May 25, 2004, is presently before the Board of Appeals. A Re-Submitted Appellant's Brief on Appeal has been filed in that matter on April 7, 2008, and no decision has been rendered with regard to the Appeal.

III. STATUS OF CLAIMS

Claims 1-74 of the application have been canceled, and claims 75-98 are currently pending in this application. An Election of Species Requirement, dated March 14, 2007, has been issued in this matter. In response to this Election of Species Requirement, the Appellant's elected Species III, directed to Fig. 8, noting that claims 87-92 are readable on the elected species. These claims 87-92 are currently under rejection for reasons set forth in the July 17, 2007 Final Office Action. The remaining pending claims 75-86 and 93-98 are currently withdrawn from consideration. The pending claims 75-86 and 93-98 are included in Appendix A for completeness, but are indicated as being withdrawn.

IV. STATUS OF AMENDMENTS

The last Amendment filed in this application was the Amendment in Response to Election of Species Requirement, filed on April 13, 2007. No Amendments have been filed since the issuance of the July 17, 2007 final rejection.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention is directed to an improved plasma etching apparatus which is particularly designed to overcome problems of uneven plasma density which have occurred in prior devices. For example, as described on page 7, line 11 et seq., of the Specification with regard to prior art plasma etching devices:

> "Further, the plasma processing apparatus is generally constructed in such a manner that the processing gas is exhausted from the peripheral portion of the sample. <u>In such a case, there is a disadvantage in that the plasma density is higher in the central portion of the sample and lower in the peripheral portion of the sample, and accordingly uniformity in the processing all over the surface of the sample is degraded."</u>

The Specification discusses various attempts which have been made to overcome this problem, but, as noted in the Background of the Invention in pages 7-10, other disadvantages arise from these previous attempts.

Accordingly, Figs. 15-29 of the present application describe several examples of embodiments of the present invention to increase plasma density at a peripheral portion of a wafer being processed. The present claims 87-92 are directed to the embodiment of Figs. 28 and 29. This embodiment is described beginning with page 62. As shown in Fig. 28, an arrangement is provided in which a sample 40 to be subjected to plasma processing is placed on an upper surface of a lower electrode 15. An upper electrode 12 is provided at a distance spaced from the sample. Processing gas is introduced from the source 36 into the vacuum processing chamber 10. In accordance with the embodiment of Fig. 28, a coil 230 and a coil 240 are provided to increase plasma density of a portion at an outer periphery of the sample 40 so as to be greater than the plasma density at the center of the sample. This distribution of plasma density is shown, for example, in Fig. 29.

More specifically, as discussed on page 62, line 7 et seq.:

> "the direction of the magnetic flux B formed by the coil 230 and the direction of the magnetic flux B' formed by the coil 240 <u>cancel each other in the central portion of the processing chamber 10 and superimpose each other in the peripheral portion and the outer portion of the peripheral portion of the processing chamber 10 as shown by the arrow.</u> As a result, the distribution of the magnetic field intensity of each position of the sample surface becomes as shown in Fig. 29."

Accordingly, as discussed on page 62, line 26 et seq.:

> "Therefore, according to the embodiment of Fig. 38 [*sic*], the cyclotron resonance effect of electrons in the central portion of the sample can be decreased and the generation of plasma in the peripheral portion and the outside portion of the peripheral portion of the sample can be increased."

Turning to the independent claim 87, a comparison will now be provided, as required under 37 CFR §41.37. As noted above, the present independent claim 87 and its dependent claims are particularly directed to the embodiment shown in Fig. 28. This embodiment is a modification of the basic embodiment shown in Fig. 1. More specifically, the arrangement of the coils 230 and 240 in Fig. 28 to achieve the uniform plasma density, discussed above, is the particular feature illustrated in Fig. 28, but, other than this, the fundamental features of the present invention correspond to those of Fig. 1 with regard to the overall structure.

More specifically, independent claim 87 defines a plasma etching apparatus that comprises a vacuum processing chamber and a pair of electrodes opposite to each other that are disposed in the vacuum processing chamber. This corresponds to the vacuum processing chamber 10 and the electrodes 12 and 15 shown in both Figs. 1 and 28, and as also discussed on page 27, lines 22 et seq., and on page 62, lines 16 et seq. Claim 87 also notes that one of the electrodes is used as a sample table capable of holding a sample. This can be read on the electrode 15 holding the sample 40, as shown in both Figs. 1 and 28. Claims 87 then goes on to define that

the sample has a diameter of 300 mm or more and contains an insulator film. Such a sample is discussed, for example, on page 13, lines 24 – 27, and page 28, lines 1 and 2, as well as on page 18, lines 19-21 (with regard to the insulator film).

The second paragraph of claim 87 is directed to a gas introducing means for introducing an etching gas containing at least fluorine and carbon into the vacuum processing chamber. This can be read on the gas supplying unit 36 used to introduce gas into the chamber, as described on page 28, line 25, through page 29, line 4. The use of a gas containing fluorine and carbon is discussed, for example, on page 7, lines 2 and 3, and page 73, line 8 et seq. of the Specification.

Paragraph 3 of claim 87 is directed to a magnetic field forming means, including a pair of coils, for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of the sample which is greater than the plasma density at the center of the sample. As noted above, such an arrangement is shown in Fig. 28, and includes the coils 230 and 240 to achieve the claimed plasma density. The structure and operation is also described on page 62, line 1 through page 63, line 2, as also noted above. This includes the features of the third paragraph with regard to arranging the pair of coils (e.g., 230, 240) so that "the magnetic flux created by one of the coils cancels the magnetic flux of the other of the coils at the center of the sample and superposes the magnetic flux of the other of the coils at the portion within the outer periphery of the sample." (e.g., see page 62, lines 7-13).

The fourth paragraph of claim 87 defines means for etching a fine pattern on the sample by providing a specific range of high frequency electric power between only 30 Mhz and 300 Mhz between the pair of electrodes, and setting the gap between the pair of electrodes of between only 30 mm and 100 mm. The particular

range for the high frequency electric power is discussed, for example, on page 13, line 26 through page 14, line 2 of the Specification. The particular gap between the pair of electrodes 12 and 15 is discussed, for example, on page 14, lines 16-19, page 27, line 27 through page 28, line 4 and page 33, lines 18 and 19 of the Specification.

The fourth paragraph of claim 87 goes on to define that the means for etching a fine pattern includes setting an atmospheric pressure inside the vacuum processing chamber of between only 0.4 Pa and 4.0 Pa, and for setting the magnetic field value only to a value smaller than 30 gauss. The setting of the atmospheric pressure between the claimed range is discussed, for example, on page 14, lines 16 and 17, and on page 33, line 13. This setting of the magnetic field value only to a value smaller than 30 gauss is discussed on page 15, lines 17-23.

With regard to the features of the fourth paragraph of claim 87, it is noted that the high frequency electric power defined for the etching means of the fourth paragraph of claim 87 can be obtained with the high frequency electric power source 16 discussed, for example, on pages 27 and 28. The setting of the atmospheric pressure inside the vacuum processing chamber is achieved by the relationship of the high frequency electric power source 16 and the processing gas in the vacuum chamber 10, as described on page 33, line 10 et seq. The setting of the magnetic field value only to a value smaller than 30 Gauss can be achieved through the setting of the high frequency electric power source 16 and the interaction with the portion of the static magnetic field generated by the magnetic field forming means 200, as described on page 29, line 12, et seq. and page 33, line 20 et seq.

Based upon the setting of these various parameters, the means for etching a fine pattern defined in the fourth paragraph of claim 87 specifically defines that a

plasma density within a range of 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} is maintained between the pair of electrodes to etch a fine pattern on the sample. This specific range of plasma density is discussed, for example, on page 33, lines 6 through 19. As noted there, the high frequency electric power source 16 operates in conjunction with the vacuum processing chamber (which would also include the magnetic forming means 200) to achieve this desired range. With regard to this, it is noted that appellants state in this portion of the Specification that this range of plasma density is preferable since "disassociation of the processing gas is not excessively progressed and [the plasma] has a uniform and large diameter."

Finally, claim 87 defines, in its last paragraph, a bias electric power source connected to one of the electrodes to control energy of ions in the plasma. This is disclosed, for example, on page 33, lines 17 through 19, which describes "an ion energy controlling bias electric source 17 ... connected to the lower electric 15 mounting the sample." This bias electric source 17 is shown, for example, in Fig. 1.

Dependent claims 88-92 each define specific features of the invention which further distinguish over the cited prior art, as will be discussed hereinafter.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claim 92 has been rejected under 35 USC §112, first paragraph, as failing to comply with the written description requirement.

Claims 87 to 92 have been rejected under 35 USC §103(a) as being unpatentable over the combination of Collins et al (USP 5,300,460) in view of Ohmi (USP 5,272,417), Lenz et al (USP 5,609,720), Heinrich et al (USP 5,527,394) and Mintz et al (USP 5,223,457).

In addition, as a second prior art rejection, utilizing the same prior art, claims 87-92 have been rejected under 35 USC §103(a) over Ohmi, in view of Collins, Lenz, Heinrich and Mintz.

In addition, as a third prior art rejection, claims 87-92 have also been rejected under 35 USC §103(a) as being unpatentable over Koshiishi et al (USP 5,919,332) in view of the above noted prior art to Lenz, Collins, Heinrich and Mintz.

VII. ARGUMENTS

A. The 35 USC §112, first paragraph, rejection of dependent claim 92.

The first rejection set forth on page 2 of the July 17, 2007 Final Office Action is a rejection of the dependent claim 92 under 35 USC §112, first paragraph, as failing to comply with the written description requirement. In particular, the rejection states that the specification portion referring to the current invention fails to disclose the claimed feature found in claim 92 of etching a fine pattern of 0.2 μm or smaller on a sample. The rejection acknowledges that the discussion of the prior art in the Specification indicates that it is difficult to manufacture such a fine pattern of 0.2 μm or smaller. The specification also admits that the discussion regarding the current invention requires manufacturing a fine pattern, but fails to give dimensions for the fine pattern.

In response, applicants respectfully submit that the relationship between the problems discussed in the Background of the Invention and the solutions thereof discussed in the Summary of the Invention, as well the detailed Specification, should permit the applicant to claim a specific size defined within the Background of the Invention concerning a problem which the applicants are trying to solve. More specifically, in the present instance, on page 6, lines 15 through 24, a problem which the present invention is directed to resolve is disclosed as follows:

> "It is difficult to obtain a uniform plasma density of 5 x 10^{10} cm^{-3} over the surface of a sample having a diameter of 300 mm or more under a pressure condition as low as 0.4 to 4 Pa. Therefore, in the two-frequency exciting method and the M-RIE method, it is difficult to manufacture the fine pattern of 0.2 μm or smaller on a wafer having a diameter larger than 300 mm uniformly and quickly with a high selectivity of the etching material to the base material."

In other words, it is quite clear from this portion of the Background of the Invention that applicants are interested in resolving a problem of obtaining uniform plasma

density of over 5×10^{10} cm^{-3} over a surface of the sample having a diameter of 300 mm, and, in particular, to etch a "fine pattern" of 0.2 µm or smaller on a wafer of such size.

Following this, on page 10, line 12 et seq., of the Specification, the first object defined for the invention is defined as follows:

> "An object of the present invention is to provide a plasma processing apparatus and a plasma processing method capable of easily performing precise manufacturing of a fine pattern on a large sized sample having a diameter of 300 mm or more by obtaining a large-sized and uniform plasma in which dissociation of the processing gas does not excessively progress."

In other words, this paragraph clearly relates to the problem described on page 6, line 15 et seq., with regard to obtaining a large sized and uniform plasma for a large sized sample having a diameter of 300 mm or more. It is respectfully submitted that, within this context, the term "a fine pattern on a large size sample having a diameter of 300 mm or more" would clearly lead one of ordinary skill in the art reading the Specification to understand that the "fine pattern" is the same fine pattern referred to on page 6, line 21 of 0.2 µm or smaller. In other words, it is respectfully submitted that it is reasonable that one of ordinary skill in the art would understand that the term "fine pattern" referred to in detail on page 6, line 21, with regard to a problem being solved by the present invention would then be used in subsequent references to a "fine pattern" in the portion of the Specification describing the solution of this problem. Therefore, reconsideration and removal of this ground of rejection is respectfully requested.

B. 35 USC §103(a) Rejection of Claims 87-92 Over Collins in view of Ohmi, Lenz, Heinrich and Mintz.

Independent claim 87, as noted above, is directed to a plasma etching apparatus including a vacuum processing chamber, a pair of electrodes, one of which holds a sample having a diameter of 300 mm or more containing an insulator film, and a gas introducing means for introducing an etching gas containing at least fluorine and carbon into the vacuum processing chamber. In combination with these features, claim 1 specifically defines:

> "a magnetic field forming means, including a pair of coils, for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of said sample which is greater than the plasma density at the center of said sample by arranging the pair of coils so that the magnetic flux created by one of the coils cancels the magnetic flux of the other of the coils at the center of the sample and superposes on the magnetic flux of the other of the coils at the portion within the outer periphery of the sample,"

It is respectfully submitted that none of the cited references, whether considered alone or in combination with one another, teach or suggest such a magnetic field forming means in combination with the other recited elements of the plasma etching apparatus.

It is admitted at the bottom of page 4 of the Final Office Action of July 17, 2007 that:

> "Collins et al fails to disclose a magnetic forming means, including a pair of coils for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of the sample which is greater than the plasma density at the center of the sample."

However, on page 5 of the Office Action, Fig. 2C and column 5, lines 26-53 of Heinrich is cited for teaching a pair of coils "for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of the sample which is greater than the plasma density at the center of the sample in order

to enhance process uniformity." Applicants respectfully submit that this is actually a mischaracterization of what Heinrich teaches.

In particular, as is evident from the outset of the Heinrich patent, Heinrich is directed to an arrangement for varying plasma volume rather than for providing an arrangement, such as defined by the independent claim 87, for providing a higher plasma density at the outer periphery of the sample than in the center of the sample. For example, the Abstract of Heinrich clearly states:

> "The present invention is distinguished by having means for varying the plasma volume."

Similarly, in the heading of the Description of the Invention in column 2, line 4 et seq., Heinrich states:

> "An element of the present invention is, therefore, to improve an apparatus for a plasma-enhanced processing of substrates in such a manner that means for varying the plasma volume are provided."

In column 2, line 11 et seq., Heinrich states:

> "The present invention is based on the fundamental concept of adjusting the individual current densities by means of concerted variation of the plasma volume. "

More specifically, not only does claim 87 define means for increasing plasma density at a portion within an outer periphery of a sample which is greater than plasma density at the center of the sample, but it also defines doing so by specifically "arranging the pair of coils so that the magnetic flux created by one of the coils cancels the magnetic flux of the other of the coils at the center of the sample and superimposes on the magnetic flux of the other of the coils at the portion within the outer periphery of the sample." Very clearly, neither Heinrich nor any of the other cited references at all teach such a particular arrangement of a pair of coils to create this combination of a canceling effect and a superimposing effect regarding magnetic flux to achieve variations in density of the plasma.

In the present invention, as discussed above, the particular arrangement of the coils to create this effect is to counteract the natural tendency in prior art devices for the plasma density to be higher in a central portion of the sample and lower in the peripheral portion of the sample (e.g., see page 7, line 13 et seq.). The magnetic field forming means defined in claim 87 is a specific way to obtain exactly the opposite effect of providing a higher plasma density at the peripheral area of the sample relative to the plasma density at the center of the sample. Although Heinrich may be of general interest regarding coils that adjust the overall volume of the plasma, there is absolutely nothing in Heinrich about providing an arrangement to achieve greater plasma density within the outer periphery of the sample relative to the plasma density at the center of the sample. Therefore, one would expect that Heinrich would have the conventional relative density arrangement, discussed on page 7, line 11 et seq. of the present specification, of the plasma density being higher at the center and lower at the periphery (exactly opposite the present claims) regardless of how they adjust the volume of the plasma. Accordingly, for these reasons, reconsideration and removal of the rejection is respectfully requested.

Another admitted shortcoming of the primary reference to Collins is discussed in the second paragraph of page 5 of the Office Action where it is stated "Collins et al in view of Heinrich et al, fails to teach the magnetic field smaller than 30 Gauss." The secondary reference to Mintz is then cited for teaching a plasma etching apparatus using a magnetic field density less than 30 Gauss to deflect plasma ions to thereby prevent wafer contamination. Applicants also respectfully submit that this combination also fails to teach or suggest the claimed invention defined in independent claim 87.

More specifically, the feature of the invention to which this pertains can be found in the fourth paragraph in which a means for etching a fine pattern includes means "for setting the magnetic field value only to a value smaller than 30 Gauss, <u>in order to maintain a plasma density within a range between 5 x 10^{10} cm^{-3} and 5 x 10^{11} cm^{-3} between said pair of electrodes to etch a fine pattern on said sample."</u> It is respectfully submitted that Mintz fails to teach or suggest this claimed means for maintaining plasma density between the claimed range, by setting a magnetic field value only to a value smaller than 30 Gauss, as required by claim. More specifically, it is respectfully submitted that neither Mintz, nor any of the other cited references, teach or suggest the claimed means to maintain the plasma density within the specific claimed range by combining the setting of the magnetic field value only to a value smaller than 30 Gauss, together with each of the other limitations defined within the fourth paragraph of claim 87 for "means for etching a fine pattern on a sample."

In the Mintz reference, column 6, lines 51-63 discusses the inclusion of a pair of electromagnetic coils 114 which produce a very weak magnetic field which is "sufficient to prevent plasma ions from impacting the walls with sufficient energy to desorb contaminates from those walls." This has absolutely nothing to do with setting a magnetic field value, in conjunction with setting a particular of high-frequency electric power, setting a gap between the pair of electrodes and setting the atmospheric pressure within a particular range "in order to maintain a plasma density within a range of between 5 x 10^{10} cm^{-3} and 5 x 10^{11} cm^{-3} between said pair of electrodes to etch a fine pattern on said sample." With regard to this, it is noted that the claim language has been specifically drafted in terms of a means for etching fine pattern on a sample by maintaining plasma density within the claimed range so

that this function would be considered. It is urged that this is completely proper in light of 35 USC 112, paragraph six, which is specifically designed to permit consideration of functional features to distinguish over prior art. In Mintz, the fact that electromagnetic coils 114 are provided to prevent plasma ions from impacting walls of the chamber gives no suggestion whatsoever of the claimed function of etching the fine pattern by maintaining the four conditions set forth in that paragraph to maintain a plasma density within the recited range.

Concerning the claimed range itself, the first full paragraph on page 6 of the Office Action cited the ranges of high frequency electric power, electrode spacing and pressure taught by Collins, and argues that "it is inherent that the resulting plasma density generated in Collins in view of Ohmi et al and Lentz et al will fall between the range of 5×10^{10} cm^{-3} to 5×10^{11} cm^{-3}." With regard to this, it is first noted that each of the ranges specified for the high frequency electric power source, the electrode spacing and the pressure on page 6, line 4 regarding Collins is different than the specific ranges called for in the fourth paragraph of claim 87. Admittedly, these ranges overlap, <u>but the ranges specified in Collins are much broader ranges than those of the present claimed invention, and would include many values which are very far outside the claimed ranges.</u> As such, there is no teaching in Collins that would lead one to actually select the three specific ranges defined by claim 87. Still further, as noted above, there is nothing in the cited prior art, including the Mintz reference, which would suggest setting a magnetic field value only to a value smaller than 30 Gauss, together with the other three specific ranges defined in the fourth paragraph of claim 87, to maintain the specific range of plasma density defined by the fourth paragraph of claim 87.

With regard to the basis of the rejection set forth in the first full paragraph of page 6 of the Office Action (i.e., that it is inherent that the resulting plasma density generated in Collins in view of Ohmi and Lentz would fall between the claimed range), it is respectfully submitted that this, in effect, is a statement that "the claimed invention is within the capabilities of one of ordinary skill in the art" as discussed on page 21-140 of the MPEP within §2143.01. As noted there,:

> "A statement that modifications of the prior art to meet the claimed invention would have been 'well within the ordinary skill of the art at the time the claimed invention was' because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references."

This section of the manual goes on to state:

> "Rejections on obviousness cannot be sustained by mere conclusory statements; instead there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." (Citing KSR, 82 USPQ 2d @ 1396).

In the present instance, not only would particular selections of the ranges taught by Collins need to be made, but a modified version of the coils of Mintz would need to be provided to meet the claimed features, including the generation of the specific plasma density range. Concerning this, it is respectfully submitted that there has been no "articulated reasoning with some rational underpinning" to support the Examiner's legal conclusion of the obviousness of the claimed means for etching a fine pattern having a plasma density within a range between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3}. As noted above, the purpose for the magnetic field intensity of Mintz is to deflect plasma ions to prevent wafer contamination. This is a completely different function than that required by the fourth paragraph of claim 87. And, in any event, it is respectfully submitted that there is absolutely no rational underpinning, as required

by KSR, for using the teachings of Mintz to modify the combination of Collins, Ohmi and Lentz to achieve this claimed function. As also noted in MPEP §2143.01:

> "The mere fact that references can be combined or modified does not render the resulted combination obvious unless ... the results would have been predictable to one of ordinary skill in the art. " (KSR International Co. v. Teleflex, Inc. 82 USPQ 2d 1385, 1396 [Supreme Court 2007]).

In the present instance, it is urged that one of ordinary skill in the art reading Mintz, and his teachings regarding using the claimed magnetic field intensity of less than 30 Gauss to deflect plasma ions would not at all have predicted that the setting of such field value, together with setting high frequency electric power, gap between electrodes and atmospheric pressure, could achieve a specific advantageous claimed range of plasma density. For these reasons, reconsideration and removal of the rejection of independent claim 87 based on Collins, in view of Ohmi, Lenz, Heinrich and Mintz, is respectfully requested.

Reconsideration and allowance of the dependent claims 88-92 over the rejection to Collins in view of Ohmi, Lenz, Heinrich and Mintz is also respectfully requested. In each case, as discussed below, these dependent claims define further specific features emphasizing additional distinctions over the cited references.

B(1) 35 USC 103(a) Rejection of Claim 88 Over Collins in View of Ohmi, Lenz, Heinrich and Mintz.

Claim 88 defines the feature of improving workability on the sample at a plasma density within the claimed range between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} . This feature operates in context with the claim limitation of the parent claim that the sample being worked on is 300 mm or larger. As noted on page 33, line 6 et seq.:

> "In order to improve the microworkability of a large diameter sample, it is preferable that a plasma generating high frequency electric power source 16 having a high frequency is used to stabilize discharge in a low pressure region. In the present invention, the plasma generating high frequency electric power source 16 is connected to the upper

> electrode 12 in order to obtain a plasma which is a low pressure of 0.4 Pa to 4.0 Pa and a plasma density of 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3}, and dissociation of the processing gas is not excessively progressed and has a uniform and large diameter."

In other words, this function of improved workability is particularly related to the generation of the specific plasma density within the claimed range, as well as the large size of the sample. In the cited prior art, there is no teaching of either the specific claimed plasma density range, or its provision of improved workability on samples of 300 mm or larger.

B(2) 35 USC 103(a) Rejection of Claims 89 and 90 Over Collins in View of Ohmi, Lenz, Heinrich and Mintz.

Dependent claims 89 and 90 further define that the pair of coils designed to generate the increased plasma density at the outer periphery each have "a position in a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample." In other words, these claims further define the achieving of the claimed function based upon the position and the diameter of the coils. In the Office Action, as discussed above, the coils Sp of Fig. 2C of Heinrich have been cited to try to meet the claimed limitation regarding the magnetic field forming means of the independent claim 87, as well as dependent claims 89 and 90. However, in addition to the shortcomings noted above regarding the Heinrich reference concerning the limitations in the third paragraph of claim 87, it is further noted that there is nothing suggesting the positioning and the diameter of the coils being used to generate increased plasma at a portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

B(3) 35 USC 103(a) Rejection of Claim 91 Over Collins in View of Ohmi, Lenz, Heinrich and Mintz

Dependent claim 91 adds the feature of setting the magnetic field intensity of the sample to be less than 30 Gauss to not only the means for etching a fine pattern in the fourth paragraph of claim 87, but also as part of the magnetic field forming means of the third paragraph of claim 87. In other words, setting the magnetic field intensity on the sample to be less than 30 Gauss is also part of the magnetic field forming means for forming the magnetic field with increased plasma density at a portion within the outer periphery of the sample which is greater than the plasma density at the center of the sample. As discussed above, the reference to Mintz, which is the only reference cited in the Office Action concerning this feature, gives absolutely no suggestion of setting magnetic field intensity to achieve the claimed difference in plasma density at the outer periphery, relative to the center of the sample. Mintz only teaches using electromagnetic coils 114 to generate a weak magnetic field to prevent plasma ions from impacting walls of the chamber. As such, there is clearly no teaching or suggestion whatsoever in Mintz, or any of the other cited references, concerning the setting of a magnetic field intensity on the sample to be less than 30 Gauss as part of the specific magnetic sealed forming means to generate increased plasma density at the outer periphery of the sample.

B(4) 35 USC 103(a) Rejection of Claim 92 Over Collins in View of Ohmi, Lenz, Heinrich and Mintz.

Finally, dependent claim 92 defines that the fine pattern of the fourth paragraph of its parent claim 87 is 0.2 μm or smaller. In other words, this effectively leads claim 92 to read as “means for etching a fine pattern of 0.2 μm or smaller” as

part of the functional limitations. As discussed at the outset of this section concerning the 35 USC §112 rejection, one of the problems specifically dealt with by the present invention is the difficulty in manufacturing a fine pattern of 0.2 µm or smaller on a wafer having a diameter of 300 mm or larger. In accordance with the present claimed invention, setting the high frequency electric power, the gap between the electrodes, the atmospheric pressure and the magnetic field value to maintain a plasma density within a range of 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} permits achieving the etching of a fine pattern of 0.2 µm or smaller on a wafer having a size of 300 mm or larger. None of the cited prior art teaches or suggests such features.

For the reasons set forth above, it is respectfully submitted that each of the dependent claims 88-92 sets forth further distinctions over the cited prior art. Therefore, separate consideration of each of these independent claims is requested by the Board of Appeals.

C. The 35 USC §103(A) Rejection Of Claims 87-92 Over Ohmi, In View Of Collins, Lenz, Heinrich And Mintz.

This rejection is similar to the above discussed rejection, but substitutes Ohmi for Collins as the primary reference. On page 9 of the Office Action, the first full paragraph also recognizes:

> "Ohmi fails to disclose a magnetic forming means, including a pair of coils, for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of the sample which is greater than the plasma density at the center of the sample."

However, once again, the rejection looks to Fig. 2c and column 5, lines 26-53 of Heinrich to attempt to make up for this admitted shortcoming of the primary reference to Ohmi in meeting the third paragraph of claim 87. In response, appellants refer to the above discussion concerning the first prior art rejection with

regard to the failure of the Heinrich reference to meet the claim limitations of the third paragraph of claim 87.

With regard to the fourth paragraph of claim 87, the last three lines of page 9 to the first full paragraph of page 10 of the Office Action again rely on Mintz to make up for the shortcomings of Ohmi in failing to teach a magnetic field smaller than 30 Gauss, and also set forth the inherency argument discussed above concerning the different ranges taught by Ohmi and Collins. As such, reference is again made to the above arguments concerning the failure of Mintz to teach or suggest the claimed feature set forth in the fourth paragraph of claim 87, and the failure of the Office Action to provide the "articulated reasoning with some rational underpinning to support the legal conclusion of obviousness" required by the KSR decision, 82 USPQ 2d @ 1396 (as stated in MPEP §2143.01). Therefore, reconsideration and removal of this rejection, utilizing Ohmi as the primary reference rather than Collins, is also respectfully requested.

C(1) The 35 USC 103(a) Rejections of Dependent Claims 89-92 Over Ohmi in View of Collins, Lenz, Heinrich and Mintz.

Similarly, separate reconsideration and allowance of each of the dependent claims 88-92 over the combination of Ohmi in view of Collins, Lenz, Heinrich and Mintz, is also respectfully requested for the specific reasons discussed above in sections B(1) to B(4) concerning the first prior art rejection utilizing Collins as the primary reference. The switching of Ohmi with Collins as the primary reference does nothing to overcome the failures of the overall combination of references to meet the specific limitations of each of the dependent claims 88-92, as discussed in detail in

Sections B(1) to B(4) of this Appeal Brief. Therefore, allowance of these dependent claims 88 to 92 is also respectfully requested over this second rejection.

D. 35 USC §103(a) Rejection of Claims 87-92 As Being Unpatentable Over Koshiishi in view of Lenz, Collins, Heinrich and Mintz.

In this rejection, the Ohmi reference is replaced by the Koshiishi reference as a primary reference. Again, it is recognized on page 14, line 3 et seq., that the primary reference to Koshiishi fails to teach the claimed magnetic forming means, and Heinrich is relied upon beginning on page 14, line 7 et seq., to make up for this shortcoming. Also, page 14, line 14 recognizes that Koshiishi in view of Heinrich fails to teach the claimed feature of the magnetic field being smaller than 30 Gauss. Once again, Mintz is relied on in the last paragraph on page 14 of the Office Action to attempt to make up for this shortcoming. As such, it is respectfully submitted that the use of Koshiishi as a primary reference fails to make up for any of the shortcomings of the above discussed prior art rejections utilizing Collins and Ohmi as primary references. Koshiishi has the same shortcomings concerning meeting the third and fourth paragraphs of independent claim 87 which Collins and Ohmi have, as discussed in detail above in Section B of this Appeal Brief. Therefore, reference to the above discussions concerning the shortcomings of the Heinrich reference and the Mintz reference in overcoming the omissions of the other cited references, in this case including Koshiishi, is respectfully requested.

D(1) The 35 USC 103(a) Rejections of Dependent Claims 89 to 92 Over Koshiishi in View of Collins, Lenz, Heinrich and Mintz.

Nothing in Koshiishi teaches or suggests the detailed features of the dependent claims 88-92 discussed above. Therefore, reference to the above

discussions concerning the separate distinctions of each of these dependent claims is also requested. Accordingly, reconsideration and removal of this third prior art rejection is also respectfully requested for the same reasons advanced in Sections B(1) to B(4) of this Appeal Brief, concerning the first prior art rejection.

VII. CONCLUSION

For the foregoing reasons, appellants request that the Examiner's rejections be reversed.

The Appeal Brief filing fee of $510.00 is being effected by electronic payment.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 520.35237VX1), and please credit any excess fees to such deposit account.

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP

By
Gregory E. Montone
Reg. No. 28,141

GEM/dks
(O) 703-312-6600

Enclosures: Appendix A (Claims)
Appendix B (Evidence Appendix)
Appendix C (Related Proceedings Appendix)

APPENDIX A

CURRENT CLAIMS

Claims 1-74. (Canceled without prejudice or disclaimer).

75. (Withdrawn) A plasma etching apparatus comprising a vacuum processing chamber and a pair of electrodes opposite to each other that are disposed in said vacuum processing chamber, one of said electrodes being used also as a sample table capable of holding a sample having a diameter of 300 mm or more containing an insulator film, wherein said plasma etching apparatus further comprises:

a gas introducing means for introducing an etching gas containing at least fluorine and carbon into said vacuum processing chamber;

a magnetic field forming means for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of said sample which is greater than the plasma density at the center of said sample by continuously rotating the magnetic field to generate the increased plasma density at the portion within the outer periphery of the sample,

means for etching a fine pattern on said sample by applying a high-frequency electric power of between only 30 MHz and 300 MHz between said pair of electrodes, and for setting the gap between said pair of electrodes of between only 30 mm and 100 mm, and for setting an atmospheric pressure inside said vacuum processing chamber of between only 0.4 Pa and 4.0 Pa, and for setting the magnetic field value only to a value smaller than 30 gauss, in order to maintain a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} between said pair of electrodes to etch a fine pattern on said sample; and

a bias electric power source connected to one of said electrodes to control energy of ions in said plasma.

76. (Withdrawn) An apparatus as in claim 75, wherein said vacuum processing chamber improves workability on a sample at a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3}.

77. (Withdrawn) An apparatus as in claim 75, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

78. (Withdrawn) An apparatus as in claim 76, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

79. (Withdrawn) An apparatus according to claim 75, wherein said magnetic field forming means includes means to set the magnetic field intensity on the sample to be less than 30 gauss.

80. (Withdrawn) An apparatus according to claim 75, wherein said fine pattern is 0.2 μm or smaller.

81. (Withdrawn) A plasma etching apparatus comprising a vacuum processing chamber and a pair of electrodes opposite to each other that are disposed in said vacuum processing chamber, one of said electrodes being used also as a sample table capable of holding a sample having a diameter of 300 mm or more containing an insulator film, wherein said plasma etching apparatus further comprises:

a gas introducing means for introducing an etching gas containing at least fluorine and carbon into said vacuum processing chamber;

a magnetic field forming means, including two pairs of coils for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of said sample which is greater than the plasma density at the center of said sample by successively switching the direction of the magnetic field in each of the pairs of coils to rotate the magnetic field, wherein the position and diameters of the coils are set to generate the increased plasma density at the portion of the outer periphery of the sample,

means for etching a fine pattern on said sample by applying a high-frequency electric power of between only 30 MHz and 300 MHz between said pair of electrodes, and for setting the gap between said pair of electrodes of between only 30 mm and 100 mm, and for setting an atmospheric pressure inside said vacuum processing chamber of between only 0.4 Pa and 4.0 Pa, and for setting the magnetic field value only to a value smaller than 30 gauss, in order to maintain a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} between said pair of electrodes to etch a fine pattern on said sample; and

a bias electric power source connected to one of said electrodes to control energy of ions in said plasma.

82. (Withdrawn) An apparatus as in claim 81, wherein said vacuum processing chamber improves workability on a sample at a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3}.

83. (Withdrawn) An apparatus as in claim 81, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

84. (Withdrawn) An apparatus as in claim 82, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

85. (Withdrawn) An apparatus according to claim 81, wherein said magnetic field forming means includes means to set the magnetic field intensity on the sample to be less than 30 gauss.

86. (Withdrawn) An apparatus according to claim 81, wherein said fine pattern is 0.2 µm or smaller.

87. (Previously Presented) A plasma etching apparatus comprising a vacuum processing chamber and a pair of electrodes opposite to each other that are

disposed in said vacuum processing chamber, one of said electrodes being used also as a sample table capable of holding a sample having a diameter of 300 mm or more containing an insulator film, wherein said plasma etching apparatus further comprises:

a gas introducing means for introducing an etching gas containing at least fluorine and carbon into said vacuum processing chamber;

a magnetic field forming means, including a pair of coils, for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of said sample which is greater than the plasma density at the center of said sample by arranging the pair of coils so that the magnetic flux created by one of the coils cancels the magnetic flux of the other of the coils at the center of the sample and superposes on the magnetic flux of the other of the coils at the portion within the outer periphery of the sample,

means for etching a fine pattern on said sample by applying a high-frequency electric power of between only 30 MHz and 300 MHz between said pair of electrodes, and for setting the gap between said pair of electrodes of between only 30 mm and 100 mm, and for setting an atmospheric pressure inside said vacuum processing chamber of between only 0.4 Pa and 4.0 Pa, and for setting the magnetic field value only to a value smaller than 30 gauss, in order to maintain a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} between said pair of electrodes to etch a fine pattern on said sample; and

a bias electric power source connected to one of said electrodes to control energy of ions in said plasma.

88. (Previously Presented) An apparatus as in claim 87, wherein said vacuum processing chamber improves workability on a sample at a plasma density within a range of between 5 x 10^{10} cm^{-3} and 5 x 10^{11} cm^{-3}.

89. (Previously Presented) An apparatus as in claim 87, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

90. (Previously Presented) An apparatus as in claim 88, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

91. (Previously Presented) An apparatus according to claim 87, wherein said magnetic field forming means includes means to set the magnetic field intensity on the sample to be less than 30 gauss.

92. (Currently Amended) An apparatus according to claim 87, wherein said fine pattern is 0.2 μm or smaller.

93. (Withdrawn) A plasma etching apparatus comprising a vacuum processing chamber and a pair of electrodes opposite to each other that are disposed in said

vacuum processing chamber, one of said electrodes being used also as a sample table capable of holding a sample having a diameter of 300 mm or more containing an insulator film, wherein said plasma etching apparatus further comprises:

a gas introducing means for introducing an etching gas containing at least fluorine and carbon into said vacuum processing chamber;

a magnetic field forming means for forming a magnetic field designed to generate increased plasma density at a portion within an outer periphery of said sample which is greater than the plasma density at the center of said sample by rotating an eccentrically arranged core of the magnetic field forming means to generate the increased plasma density at the portion within the outer periphery of the sample,

means for etching a fine pattern on said sample by applying a high-frequency electric power of between only 30 MHz and 300 MHz between said pair of electrodes, and for setting the gap between said pair of electrodes of between only 30 mm and 100 mm, and for setting an atmospheric pressure inside said vacuum processing chamber of between only 0.4 Pa and 4.0 Pa, and for setting the magnetic field value only to a value smaller than 30 gauss, in order to maintain a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3} between said pair of electrodes to etch said fine pattern on said sample; and

a bias electric power source connected to one of said electrodes to control energy of ions in said plasma.

94. (Withdrawn) An apparatus as in claim 93, wherein said vacuum processing chamber improves workability on a sample at a plasma density within a range of between 5×10^{10} cm^{-3} and 5×10^{11} cm^{-3}.

95. (Withdrawn) An apparatus as in claim 93, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

96. (Withdrawn) An apparatus as in claim 94, wherein the magnetic field forming means includes a pair of coils each having a position and a diameter to generate increased plasma at the portion within the outer periphery of the sample which is greater than the plasma at the center of the sample.

97. (Withdrawn) An apparatus according to claim 93, wherein said magnetic field forming means includes means to set the magnetic field intensity on the sample to be less than 30 gauss.

98. (Withdrawn) An apparatus according to claim 93, wherein said fine pattern is 0.2 μm or smaller.

APPENDIX B

EVIDENCE APPENDIX

EVIDENCE APPENDIX

None.

APPENDIX C

RELATED PROCEEDINGS APPENDIX

RELATED PROCEEDINGS

None.